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# The impact of financial crises and tolerance for uncertainty

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ABSTRACT

Financial crises can have severe negative effects on investment. One reason for this is that financial crises increase uncertainty, increasing the real option value of delaying investment. In this paper, we show that the negative effect of crises on investment differs significantly across countries: in countries with low tolerance for uncertainty, the negative effect is strong. The negative effect is absent in countries that are more tolerant of uncertainty. These findings are similar across different types of financial crisis; they vary as predicted across type of investor, asset and industry; and they are not driven by uncertainty-averse countries adopting more rigid institutions.



## 1. Introduction

Financial crises have large economic consequences. Many studies focus on the effect on GDP growth, e.g. Hutchison and Noy (2005) find that currency or banking crises decrease output by 5 to 10% after (up to) four years. In a recent contribution, Joyce and Nabar (2009) showed how banking crises have a severe negative impact on investment, leading to a faster drop in investment than in output.[1] One reason for this is that a financial crisis is typically a period of heightened uncertainty and as Bloom (2009) and Bloom et al. (2007) show, firms typically delay their investments in uncertain times.[2] As an illustration, Fig. 1 shows how uncertainty, proxied by the implied volatility of the U.S. stock market, rose dramatically in late 2008 as the financial crisis took hold there.[3]

However, not everyone reacts to uncertainty in the same way: individuals in some societies go to greater lengths to avoid uncertainty than those in other societies. This difference in the response to uncertainty shocks can have substantial effects on economic outcomes. In their overview of the literature, Guiso et al. (2006) argue that cultural factors have clear effects on economic outcomes.[4] A more specific example is Huang (2008), who shows that informationally opaque industries grow faster in countries with a greater tolerance for uncertainty.

In this paper, we analyze how the effect of a financial crisis on investment differs across countries. For this analysis, we construct a dataset covering 74 countries for the period 1970–2005, using the Hofstede (2001) data to measure the degree of uncertainty avoidance in each country. Financial crises are identified based on a new database by Laeven and Valencia (2008), which distinguishes between three types of crises: currency, banking and debt crises.

We find that investment significantly decreases relative to GDP only in countries that exhibit a high degree of uncertainty avoidance. We also find that each type of financial crisis has an effect on investment that is very similar in size and almost the same set of countries experiences a significant drop in investment after any type of financial crisis. In contrast, the existing literature on how crises affect the real economy tends to focus on crisis-specific explanations, such as how a currency crisis affects the decision of multinationals to invest in a local subsidiary[5]; how a banking crisis can hamper the channeling of savings into investment[6]; or how private firms have less

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[1] Other studies analyzing the effect of crises on investment include Edwards (2002) and Park et al., 2003.

[2] See Dixit and Pindyck (1994) on real option theory in general. Specifically, this insight has pervaded the study of firm investment behavior; see e.g. the survey by Carruth et al. (2000).

[3] This figure is modeled on a similar figure in Bloom (2009).

[4] In this paper we follow the argument in the literature that differences in values, such as uncertainty avoidance, will also exist within countries but that comparing averages of these values across countries is potentially meaningful.

[5] Bosworth and Collins (1999).

[6] Calvo et al. (2004).

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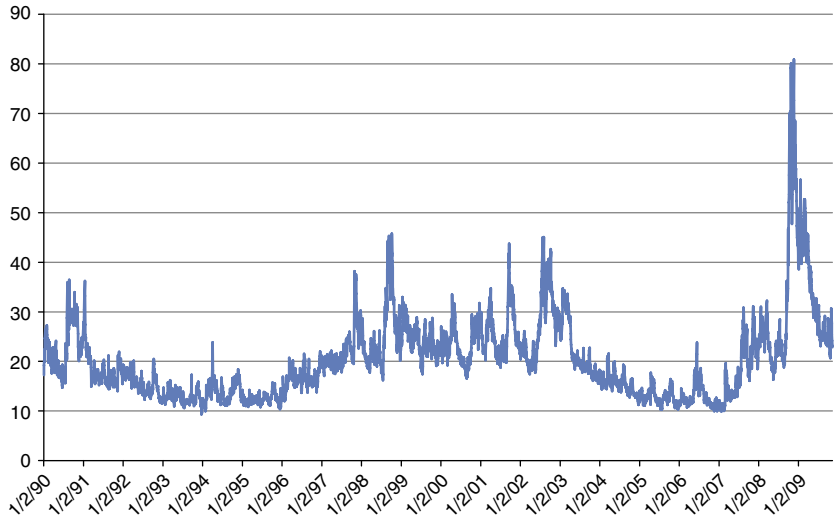



**Fig. 1.** Daily US implied stock market volatility, 1990–2009.

access to international debt markets after a sovereign debt crisis.[7] However, it seems plausible that any crisis increases uncertainty about the future, providing an explanation for the similarity in the negative response of investment across different types of crisis.

To strengthen our findings we also consider various ways of splitting up total investment.[8] We hypothesize that cross-country heterogeneity in the response to a financial crisis would:

1) only hold for private investment but not for public investment as political considerations would likely trump comparisons of real option values;
2) be stronger for investment in structures than for investment in machinery and equipment since structures are longer-lived assets and hence a longer-lasting drag on costs in case of an untimely investment;
3) be less important for investment by industries that are already highly volatile since such industries would tend to draw more risk-averse investors.[9] Alternatively, financial crises add relatively less to total industry uncertainty compared with less-volatile industries.

A distinction between public and private investment and between investment in structures and machinery and equipment is not readily available for the range of countries we consider, so we develop new estimates using National Accounts, UNIDO industry statistics and trade data. Industry investment is sourced from the UNIDO INDSTAT3 database and we define highly volatile industries using the standard deviation of daily stock returns of global sectoral stock indices from Datastream.[10] Our empirical results provide support for each of these three hypotheses.

To establish the robustness of our findings, we also consider a number of econometric techniques, from fixed-effect estimation to dynamic-panel data models.[11] We account for the possible endogeneity of the tolerance for uncertainty by using religious composition of the population as instruments (following Huang, 2008) and consider a range of legal and governance indicators that could be more proximate causes for our findings. For example, more uncertainty-averse countries may adopt stricter employment-protection regulations and such regulations may also increase the adjustment costs to capital. We also examine a wide range of other variables that could affect investment or investment after a crisis, including openness to trade, financial openness, foreign direct investment and financial development. Finally, we restrict our sample to various classes, such as low-income countries, as well as examine various alternative measures for uncertainty avoidance. Throughout these robustness checks, our main result stands: financial crises have a significant negative effect on investment only in countries with a low tolerance for uncertainty. And, as far as we are able to establish, this does not reflect a more rigid regulatory or political system but may instead reflect the risk preferences of firm owners.

This does not imply that financial crises have no economic consequences in countries with a low degree of uncertainty avoidance. Since we measure investment relative to GDP, our findings indicate that investment does not fall by significantly more than GDP in these countries. The results do imply that the long-term consequences of a financial crisis will be less severe, since the accumulation of capital is less affected than in countries with a high degree of uncertainty avoidance. We are also not claiming that financial crises only have an economic effect through increased uncertainty, but we do argue that the degree of uncertainty aversion plays an important role in *how* an economy responds to a financial crisis.[12] This finding is useful as it suggests that policy makers should take steps to reduce uncertainty to mitigate the economic effects of a financial crisis. Such confidence-building steps would be particularly important in countries that have low tolerance for uncertainty. More generally, it emphasizes in a new context the importance of cultural differences on economic outcomes.

## 2. Data

In this study we cover 74 countries, the maximum number for which data on the degree of uncertainty avoidance is available (see Table 3 for a full list). For each of these countries, we also have information on investment, GDP and whether a financial crisis took place between 1970 and 2005. This constitutes our core sample. For

[7] Arteta and Hale (2008). Their finding could be explained by a lower willingness of foreign creditors to lend money, but also by an uncertainty-induced drop in demand for funds.

[8] We thank an anonymous referee and the editor for these suggestions.

[9] See e.g. Barsky et al. (1997) and Dohmen et al. (2011) for the effect of differences in risk preferences for investment behavior.

[10] This identification strategy is in the same spirit as that of Bekaert et al. (2007).

[11] Namely the Arrelano and Bover (1991) (Difference-GMM) and Blundell and Bond (1995)/Arellano and Bover (1998) System-GMM estimators.

[12] Direct measures of uncertainty, as used in Fig. 1, do not have the strong effects we find for financial crises.

some of the formerly Communist countries, there is no data for the 1970s and 1980s, but on average we have more than 32 years of observations per country. In addition to our core data, we also collected data on numerous other variables that we use in our robustness analysis. All variables are briefly described in Table 1 and some are discussed in more detail in the data appendix.

We identify financial crises using a new database constructed by Laeven and Valencia (2008). They consider three types of financial crisis, namely a (systemic) banking crisis, a currency crisis and a (sovereign) debt crisis. The banking crises database extends the earlier work by Caprio et al. (2005), which is already widely used. We do not consider abrupt reversals of capital flows, 'sudden stops', as a separate type of crisis since Joyce and Nabar (2009) show that a sudden stop only has a negative effect on investment in the presence of a banking crisis. As outlined in Table 1, a banking crisis is identified as a situation where systemically important financial institutions are in distress. Financial distress of isolated banks is therefore not considered a banking crisis. A banking crisis is said to occur if there is a deposit run; a deposit freeze or blanket guarantee; extensive liquidity support; bank interventions; a large proportion of non-performing loans; or an exhaustion of capital of the banking system. Currency crises are identified as a year with a rapidly depreciating

**Table 1**
List of variables, definitions and sources.

| Variable | Definition | Source |
|---|---|---|
| *Crises* | | |
| Bank crisis | Systemically important financial institutions are in distress (0/1) | Laeven and Valencia (2008) |
| Currency crisis | Depreciation of the nominal exchange rate of at least 30% that is at least a 10% faster depreciation than the year before (0/1) | Laeven and Valencia (2008) |
| Debt crisis | Sovereign default to private lending (0/1) | Laeven and Valencia (2008) |
| Financial crisis | Bank, currency or debt crisis (0/1) | Laeven and Valencia (2008) |
| *Investment and output* | | |
| Investment | The log of (gross fixed capital formation at constant prices divided by GDP at constant prices) | UN National Accounts |
| Growth | Annual growth of GDP at constant prices | UN National Accounts |
| Public investment | The log of (government gross fixed capital formation at constant prices divided by GDP at constant prices) | UN National Accounts, EU KLEMS, National Accounts Argentina, see Data Appendix |
| Private investment | The log of (total minus government gross fixed capital formation at constant prices divided by GDP at constant prices) | UN National Accounts, EU KLEMS, National Accounts Argentina, see Data Appendix |
| Structure investment | The log of (construction industry output at constant prices divided by GDP at constant prices) | UN National Accounts, EU KLEMS, OECD and GTAP IO tables, see Data Appendix |
| Machinery & eq. investment | The log of (investment equipment industry output plus imports minus exports at constant prices divided by GDP at constant prices) | UNIDO INDSTAT3 and 4, World Trade Flows, see Data Appendix |
| Industry investment | The log of (industry gross fixed capital formation divided by industry value added) | UNIDO INDSTAT3, see Data Appendix |
| Industry volatility | The standard deviation of daily sectoral stock index returns | Datastream, see Data Appendix |
| WDI I/Y | log of (Investment to GDP ratio) | World Bank (2007) |
| *Cultural and religious characteristics* | | |
| UAI | Uncertainty Avoidance Index | Hofstede (2001) |
| Hoppe UAI | Uncertainty Avoidance Index from Hoppe's Survey on Salzburg Seminar Elite Alumni | Hofstede (2001) |
| EMMS UAI | Uncertainty Avoidance Index from European Media and Marketing Survey (EMMS) | Hofstede (2001) |
| WVS Risk-loving | Weighted score based on question 'How important is adventure and risk-taking' with higher scores indicating less affinity with risk-taking | World Values Survey, 2005–07 wave |
| Protestant share | Share of protestants in the population in 1980 | Barrett (1982); from La Porta et al. (1999) |
| Catholic share | Share of catholics in the population in 1980 | Barrett (1982); from La Porta et al. (1999) |
| *Economic control variables* | | |
| Interest rate | Lending interest rate | World Bank (2007) |
| Inflation | Annual change in the GDP deflator | World Bank (2007) |
| Trade Openness | Trade (Imports + Exports) (% of GDP) | UN National Accounts |
| Debt service | Total debt services (% of GDP) | World Bank (2007) |
| FDI | Foreign direct investment (% of GDP) | World Bank (2007) |
| Terms of trade | Change in terms of trade (%) | World Bank (2007) |
| Fin. Openness | Foreign assets + liabilities (% of GDP) | Lane et Milesi-Ferretti (2007), updated & extended |
| Fin. Develop. | Private credit by deposit money banks and other financial institutions (% of GDP) | Beck et al., (2000), updated |
| *Institutional and governmental control variables* | | |
| Emp. Protect. | Index of protection of labor and employment laws based on hiring and firing and working hours regulations | Botero et at., (2004) |
| Formalism | Legal formalism index, average of check and eviction case | Djankov et at., (2003) |
| Case law | Dummy variable that is one if case law is a source of law | La Porta et al. (2004) |
| Voice | Voice and accountability index, average over 1996–2009 | World Governance Indicators 1996–2009, Kaufman et al. (2010) |
| Stability | Political stability index, average over 1996–2009 | World Governance Indicators 1996–2009, Kaufman et al. (2010) |
| Effectiveness | Government effectiveness index, average over 1996–2009 | World Governance Indicators 1996–2009, Kaufman et al. (2010) |
| Reg. Qual. | Regulatory quality index, average over 1996–2009 | World Governance Indicators 1996–2009, Kaufman et al. (2010) |
| Rule of Law | Rule of Law index, average over 1996–2009 | World Governance Indicators 1996–2009, Kaufmann et al. (2010) |
| Corruption | Control of corruption index, average over 1996–2009 | World Governance Indicators 1996–2009, Kaufman et al. (2010) |

**Table 2**
Financial crisis descriptive statistics.

| Type of crisis | # of obs | Frequency (%) |
|---|---|---|
| No crisis | 2505 | 94.0 |
| Any financial crisis | 159 | 6.0 |
| Only banking crisis | 53 | 2.0 |
| Only currency crisis | 76 | 2.9 |
| Only debt crisis | 14 | 0.5 |
| Banking & currency crisis | 4 | 0.2 |
| Banking & debt crisis | 0 | 0.0 |
| Currency & debt crisis | 8 | 0.3 |
| Banking, currency & debt crisis | 4 | 0.2 |
| Total # of country/year observations | 2664 | 100 |

exchange rate, building on the approach of Frankel and Rose (1996). A debt crisis refers to the year of a sovereign default on privately held debt.

Table 2 provides an overview of the frequency with which these crises occur in our sample, while Table 3 shows the crisis years for the list of countries by type of crisis.[13] Financial crises are fairly rare in this sample, occurring in 159 of the country/year observations. This corresponds to 6% of all country/year observations. There are only a few cases where two or even all three types of crises occur in the same year. Given the rarity of double and triple crises, we do not examine these separately in our analysis. Furthermore, Hutchison and Noy (2005) do not find evidence of feedbacks or interactive effects of combined banking and currency crises.

For our analysis, we rely on the uncertainty avoidance data constructed by Hofstede (2001). The work of Hofstede (1980, 2001) has done much to show how people that are in many ways similar can still have very different values and attitudes depending on the country from which they originate. Hofstede's surveys were done around 1970 and covered 88 000 IBM employees working in similar marketing and customer service positions. This should eliminate numerous idiosyncratic differences between people and help focus on the cross-country differences. Hofstede distinguishes four cultural dimensions but we focus on uncertainty avoidance.[14] He defines uncertainty avoidance as "feeling uncomfortable with uncertainty and ambiguity, and therefore valuing beliefs and institutions that provide certainty and conformity." This overall measure is based on the responses to three questions, namely:

1) Rule orientation: the importance to the respondent of abiding by company rules;
2) Employment stability: how many years the respondent is likely to continue working for the company; and
3) Stress: whether the respondent frequently experiences stress.

Hofstede (2001) gives a more extensive discussion of these surveys, including psychological motivation, but this is also available in a more compact fashion in Huang (2008). The uncertainty avoidance indicator has been used in a range of other recent studies to establish a link between this cultural factor and economic outcomes, for example, Beugelsdijk and Frijns (2010) and Kwok and Tadesse (2006). A more general discussion of the effect of culture on economic outcomes is given in Guiso et al. (2006) and Beugelsdijk and Maseland (2010).

Table 3 provides a list of countries we cover and their degree of uncertainty avoidance according to Hofstede (2001). As indicated by asterisks, not all scores reported in the first column are based on Hofstede's original survey work. In particular, some have been estimated by Hofstede, while for some countries in the Middle East and Africa, survey responses have been pooled so that, e.g. Kenya and Tanzania have the same score. Our results are very similar if the countries denoted by asterisks are removed from the sample; see Table 9. As discussed in Hofstede (2001), there have been two alternative surveys on uncertainty avoidance that are based on different sets of respondents and taken at different times.[15] A drawback of these alternative surveys is that they cover many fewer countries.

We also include a measure based on the World Values Survey (WVS). This survey has no direct counterpart to the concept of uncertainty avoidance, but it does contain a question on the importance of risk and adventure for the respondent. We construct this measure so that a higher value corresponds to a lower affinity to risk and adventure.[16] A drawback of the WVS is that the sample is not as homogenous as that of Hofstede, potentially introducing idiosyncratic factors into this measure, and the fact that it measures a different concept. As the final line of Table 3 shows, the various measures of uncertainty avoidance are all positively correlated, and quite strongly for the Hoppe and EMMS measures.

The next two columns of Table 3 show the share of Catholics and Protestants in the population in 1980. The hypothesis is that religious background may have some explanatory power for the degree of uncertainty avoidance. This follows Weber (1930) who argued that there is a link between the Protestant Reformation and the rise of capitalism. He quotes from a study of German Catholics and Protestants: "The Catholic is quieter, having less of the acquisitive impulse; he prefers a life of the greatest possible security, even with a smaller income, to a life of risk and excitement, even though it may bring the chance of gaining honour and riches. The proverb says jokingly, 'either eat well or sleep well'. In the present case the Protestant prefers to eat well, the Catholic to sleep undisturbed."[17] The correlation between the share of these religions in the population and uncertainty avoidance is indeed as hypothesized with more Catholic countries showing a higher degree of uncertainty avoidance and more Protestant countries a lower degree.[18] The broader distinction between Catholics and Protestants has also been exploited in a number of more recent studies, e.g. Landes (1998), La Porta et al. (1999) and Huang (2008).

## 3. Methodology

Our basic model for estimating the effect of uncertainty avoidance on investment builds on that of Joyce and Nabar (2009). Our dependent variable is the log of real investment over real GDP ($iy$) in country $i$ in year $t$, which we explain using the following model[19]:

$$iy_{it} = \alpha_i + \alpha_t + \beta_1 C^k_{it} + \beta_2 C^k_{it-1} + \gamma_1 C^k_{it} \times UAI_i + \gamma_2 C^k_{it-1} \times UAI_i + \sum_{j=1}^{N} \delta_j X_{ijt} + \varepsilon_{it} \quad (1)$$

where $C$ is a dummy that is one when a country experienced a crisis of type $k$ in that year and zero otherwise. As discussed in the previous

[13] Appendix Table 1 provides descriptive statistics for the other variables.
[14] The other three dimensions are masculinity, power distance and individuality. The scores on these dimensions show very low correlations (<0.2) with the scores on uncertainty avoidance.
[15] These are *Hoppe's Survey on Salzburg Seminar Elite Alumni* and *European Media and Marketing Survey (EMMS) 1997*.
[16] The answers to this question were given on a 6-point Likert scale ranging from 'very much like me' to 'not at all like me'. These answers were given a weight going from −2.5 for 'very much like me' to +2.5 for 'not at all like me' at 1-point intervals. The share of respondents in each category was multiplied with this weight and the sum of this provides the score shown in Table 3.
[17] The original study is in German, Offenbacher (1901).
[18] The (absolute) correlations increase from about 0.4 to 0.6-0.7 if the countries with very few Christians (a combined share less than 20%) are removed.
[19] This model presupposes a cointegrating relationship between investment and GDP. A more flexible formulation where the cointegrating relationship is estimated and investment is used as the dependent variable, as in e.g. Davis and Stone (2004), leads to very similar results.

**Table 3**
Uncertainty avoidance and religious composition.

| | Uncertainty avoidance index | | | Risk loving | Religious composition in 1980 | | Financial crises | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hofstede | Hoppe | EMMS | WVS | Catholic | Protestant | Currency | Banking | Debt |
| Argentina | 0.86 | | | 0.76 | 91.6 | 2.7 | 1975, 1981, 1987, 2002 | 1980, 1989, 1995, 2001 | 1982, 2001 |
| Australia | 0.51 | | | 0.66 | 29.6 | 23.5 | | | |
| Austria | 0.70 | 0.33 | 0.50 | | 88.8 | 6.5 | | | |
| Bangladesh | 0.60* | | | | 0.2 | 0.2 | 1976 | 1987 | |
| Belgium | 0.94 | 0.67 | 0.78 | | 90.0 | 0.4 | | | |
| Brazil | 0.76 | | | 0.98 | 87.8 | 4.0 | 1976, 1982, 1987, 1992, 1999 | 1990, 1994 | 1983 |
| Bulgaria | 0.85* | | | 0.42 | 0.5 | 0.4 | 1996 | 1996 | 1990 |
| Canada | 0.48 | | | 0.33 | 46.6 | 29.6 | | | |
| Chile | 0.86 | | | 0.47 | 82.1 | 1.9 | 1972, 1982 | 1976, 1981 | 1983 |
| China, P.R. | 0.30* | | | 1.09 | 0.0 | 0.0 | | 1998 | |
| Colombia | 0.80 | | | | 96.6 | 0.9 | 1985 | 1982, 1998 | |
| Costa Rica | 0.86 | | | | 90.5 | 5.8 | 1981, 1991 | 1987, 1994 | 1981 |
| Czech Republic | 0.74* | | | | 39.2 | 4.6 | | 1996 | |
| Denmark | 0.23 | −0.02 | 0.07 | | 0.6 | 95.2 | | | |
| Ecuador | 0.67 | | | | 96.4 | 1.9 | 1982, 1999 | 1982,1998 | 1982, 1999 |
| Egypt | 0.68** | | | 1.14 | 0.2 | 0.2 | 1979, 1990 | 1980 | 1984 |
| El Salvador | 0.94 | | | | 96.2 | 2.4 | 1986 | 1989 | |
| Estonia | 0.60* | | | | 2.0 | 66.0 | 1992 | 1992 | |
| Ethiopia | 0.52** | | | −0.16 | 0.7 | 3.8 | 1993 | | |
| Finland | 0.59 | 0.31 | 0.34 | 0.75 | 0.1 | 93.1 | 1993 | 1991 | |
| France | 0.86 | 0.54 | 0.90 | 0.60 | 76.4 | 2.4 | | | |
| Germany | 0.65 | 0.37 | 0.62 | 1.03 | 35.0 | 46.4 | | | |
| Ghana | 0.54** | | | −0.72 | 18.7 | 25.8 | 1978, 1983, 1993, 2000 | 1982 | |
| Greece | 1.12 | 0.47 | | | 0.4 | 0.1 | 1983 | | |
| Guatemala | 1.01 | | | | 94.0 | 4.9 | 1986 | | |
| Hong Kong | 0.29 | | | | 7.9 | 7.5 | | | |
| Hungary | 0.82* | | | | 53.9 | 21.6 | | 1991 | |
| India | 0.40 | | | −0.52 | 1.3 | 1.1 | | 1993 | |
| Indonesia | 0.48 | | | −0.39 | 2.7 | 4.8 | 1979, 1998 | 1997 | 1999 |
| Ireland | 0.35 | 0.35 | 0.49 | | 95.3 | 1.1 | | | |
| Israel | 0.81 | | | | 1.0 | 0.2 | 1975, 1980, 1985 | 1977 | |
| Italy | 0.75 | 0.44 | 0.79 | | 83.2 | 0.4 | 1981 | | |
| Jamaica | 0.13 | | | | 9.6 | 55.5 | 1978, 1983, 1991 | 1996 | 1978 |
| Japan | 0.92 | | | 1.34 | 0.6 | 0.9 | | 1997 | |
| Kenya | 0.52** | | | | 26.4 | 19.3 | 1993 | 1985, 1992 | |
| Korea, Republic of | 0.85 | | | −0.02 | 3.9 | 12.2 | 1998 | 1997 | |
| Kuwait | 0.68** | | | | 2.1 | 0.1 | | 1982 | |
| Lebanon | 0.68** | | | | 36.2 | 1.0 | 1984, 1990 | 1990 | |
| Libya | 0.68** | | | | 0.2 | 0.1 | 2002 | | |
| Luxembourg | 0.70* | | | | 93.0 | 1.2 | | | |
| Malaysia | 0.36 | | | 0.30 | 2.8 | 1.4 | 1998 | 1997 | |
| Mexico | 0.82 | | | 0.59 | 94.7 | 1.2 | 1977, 1982, 1995 | 1981, 1994 | 1982 |
| Morocco | 0.68* | | | 0.18 | 0.2 | 0.0 | 1981 | | 1980 1983 |
| Netherlands | 0.53 | 0.14 | 0.45 | 0.47 | 42.6 | 42.4 | | | |
| New Zealand | 0.49 | | | | 18.7 | 37.9 | | | |
| Nigeria | 0.54** | | | | 12.1 | 15.8 | 1983, 1989, 1997 | 1991 | 1983 |
| Norway | 0.50 | 0.22 | 0.33 | 0.15 | 0.3 | 97.8 | | 1991 | |
| Pakistan | 0.70 | | | | 0.5 | 0.8 | 1972 | | |
| Panama | 0.86 | | | | 85.0 | 5.2 | | 1988 | 1983 |
| Peru | 0.87 | | | 0.71 | 95.1 | 2.7 | 1976, 1981, 1988 | 1983 | 1978 |
| Philippines | 0.44 | | | | 84.1 | 3.8 | 1983, 1998 | 1983, 1997 | 1983 |
| Poland | 0.93* | | | 0.22 | 81.0 | 0.1 | | 1992 | 1981 |
| Portugal | 1.04 | 0.24 | 0.81 | | 94.1 | 1.1 | 1983 | | |
| Romania | 0.90* | | | 0.87 | 4.9 | 5.8 | 1996 | 1990 | 1982 |
| Russia | 0.95* | | | 0.76 | 1.4 | 0.0 | 1998 | 1998 | 1998 |
| Saudi Arabia | 0.68** | | | | 0.1 | 0.1 | | | |
| Sierra Leone | 0.54** | | | | 2.2 | 4.8 | 1983, 1989, 1998 | 1990 | 1977 |
| Singapore | 0.08 | | | | 4.7 | 2.6 | | | |
| Slovakia | 0.51* | | | | 74.0 | 8.4 | | 1998 | |
| South Africa | 0.49 | | | −0.21 | 10.4 | 39.0 | 1984 | | 1985 |
| Spain | 0.86 | 0.27 | 0.90 | 0.27 | 96.9 | 0.1 | 1983 | 1977 | |
| Suriname | 0.92* | | | | 36.0 | 36.6 | 1990, 1995, 2001 | | |
| Sweden | 0.29 | 0.08 | 0.09 | 0.54 | 1.4 | 68.4 | 1993 | 1991 | |
| Switzerland | 0.58 | 0.44 | 0.62 | 0.81 | 52.8 | 43.2 | | | |
| Tanzania | 0.52** | | | | 28.2 | 11.2 | 1985, 1990 | 1987 | 1984 |
| Thailand | 0.64 | | | 0.15 | 0.4 | 0.2 | 1998 | 1983, 1997 | |
| Trinidad and Tobago | 0.55* | | | 0.21 | 35.8 | 13.2 | 1986 | | 1989 |
| Turkey | 0.85 | 0.39 | | 0.27 | 0.1 | 0.0 | 1978, 1984, 1991, 1996, 2001 | 1982, 2000 | 1978 |
| United Kingdom | 0.35 | 0.33 | 0.54 | 0.30 | 13.1 | 16.1 | | | |
| United States | 0.46 | 0.16 | | 0.54 | 30.0 | 43.6 | | 1988 | |
| Uruguay | 1.00 | | | 0.88 | 59.5 | 1.9 | 1972, 1983, 1990, 2002 | 1981, 2002 | 1983, 2002 |
| Venezuela | 0.76 | | | | 94.8 | 1.0 | 1984, 1989, 1994, 2002 | 1994 | 1982 |
| Vietnam | 0.30* | | | 0.79 | 3.9 | 0.2 | 1972, 1981, 1987 | 1997 | 1985 |

**Table 3** (*continued*)

| | Uncertainty avoidance index | | | Risk loving | Religious composition in 1980 | | Financial crises | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hofstede | Hoppe | EMMS | WVS | Catholic | Protestant | Currency | Banking | Debt |
| Zambia | 0.52** | | | −0.28 | 26.2 | 31.9 | 1983, 1989, 1996 | 1995 | 1983 |
| Correlation with Hofstede UAI | | 0.64 | 0.85 | 0.30 | 0.42 | −0.40 | | | |

Source: UAI data based on Hofstede (2001), original index divided by 100. Hofstede is the data from his original survey and further estimates; see Table 1 for further sources and variable descriptions.
* Estimated by Hofstede (2001).
** Regional figure for Arab World (Egypt, Kuwait, Lebanon, Libya and Saudi Arabia), East Africa (Ethiopia, Kenya, Tanzania and Zambia) or West Africa (Ghana, Nigeria and Sierra Leone).

section, our data cover three types of financial crises: banking, currency and debt crises. As our fourth and main 'type', we define $C$ to be equal to one if any of these three crises occurred. The reason for focusing on this definition is that *any* financial crisis is likely to lead to a period of increased uncertainty, but we also analyze the three types separately. We also include a lagged value of the crisis variable since the effects of a crisis may take longer than a year to dissipate. In particular if a crisis occurs late in the year, the effects may well spill over into the next. In addition to the crises variable, we include country and year fixed effects, denoted by $\alpha_i$ and $\alpha_t$, to capture time-invariant country-specific factors and shocks that are common across countries in a single year.

We also include other control variables, denoted by $X$. In our baseline model, we include just the lagged dependent variable and lagged GDP growth. Since we aim to maximize the number of countries covered to identify the cross-country heterogeneity in response to a crisis, we cannot have many control variables in our baseline specification. However, as we show in the robustness analysis (Table 8), the inclusion of other variables does not affect our main result.

Of key interest in this study are the interaction effects between current and lagged crises and the country uncertainty avoidance index. The significance of these interaction effects provide some information, but the main focus should be on the marginal effects to find out how investment responds to a financial crisis in countries with different degrees of tolerance for uncertainty[20]:

$$\frac{\partial iy_{it}}{\partial C_{it}} = \beta_1 + \gamma_1 UAI_i \tag{2}$$

and a similar calculation can be made for the effects of a crisis a year ago.

When analyzing the robustness of our findings, the key issue is how any control variables may influence the marginal effect from equation (2). We therefore interact any control variable with current and lagged crises and evaluate the following marginal effect:

$$\frac{\partial iy_{it}}{\partial C_{it}} = \beta_1 + \gamma_1 UAI_i + \delta_{j2} X^j_{it} \tag{3}$$

where $\delta_{j2}$ is the coefficient on the interaction between a crisis (current or lagged) and control variable $j$.

As mentioned in the Introduction, we also analyze to what extent industries show a different response to a financial crisis, depending on the uncertainty aversion of the country and the volatility of the industry[21]:

$$iy_{ikt} = \alpha_{ik} + \alpha_t + \beta_1 iy_{ikt-1} + \beta_2 C_{it} + \beta_3 C_{it} \times UAI_i + \beta_4 C_{it} \times V_k + \beta_5 C_{it} \times UAI_i \times V_k + \varepsilon_{ikt} \tag{4}$$

In this equation, we analyze the investment-output ratio in country $i$, industry $k$ at time $t$. $V$ is the volatility of industry $k$ and is taken as constant across countries and over time. Industry volatility is measured as the standard deviation of daily stock market returns of global sectoral indexes compiled by Datastream. These indexes have earlier been used by Bekaert et al. (2007), who argue that their global nature make them exogenous to economic developments in any particular country. By also averaging over time, this exogeneity is further strengthened and allows us to compare how the investment response to a crisis varies not just by country uncertainty aversion but also by industry volatility. To that end, we evaluate the following marginal effect for different values of uncertainty aversion and industry volatility:

$$\frac{\partial iy_{ikt}}{\partial C_{it}} = \beta_2 + \beta_3 UAI_i + \beta_4 V_k + \beta_5 UAI_i \times V_k \tag{5}$$

## 4. Results

Column (1) in Table 4 shows the results for a model with just a current crisis as an explanatory variable in addition to lagged investment and lagged growth. The column is labeled 'FE' for fixed effects to denote that country fixed effects are included (in addition to year effects) and that this equation is estimated using ordinary least squares (OLS). Investment is a very persistent process as the coefficient on lagged investment is large and highly significant. This could reflect partial adjustment in investment behavior.[22] Lagged growth is only significant at a 10% level (and insignificant in some of the other specifications), suggesting that for this sample of 74 countries, a flexible accelerator effect is not very clear. The effect of a financial crisis is highly significant and substantial, reducing investment by over 5% relative to GDP. This means the investment to GDP ratio drops by about 1 percentage point, close in size to what Joyce and Nabar (2009) find. The explanatory power of the regression is sizeable with a (within) adjusted R-squared of about 75%, though the lagged dependent variable accounts for much of this. The second column shows that the effect one year after a crisis is even more considerable, implying a total drop in investment relative to GDP of more than 12%, or more than 2 percentage points.[23]

The third column adds the two interaction effects, for current and lagged crises. This causes the crisis and lagged crisis coefficient to turn positive, but these coefficients now measure the effect of a financial crisis in a (hypothetical) country where UAI is equal to zero (see equation (2)). Both interaction terms are negative and significant, though the lagged interaction only at the 10-percent level. Since UAI is always larger than zero, the point estimate of the marginal effect from equation (2) is never positive, let alone significantly so. The country

[20] See Brambor et al. (2006) for more on estimating and interpreting interaction models. They recommend including both constituent terms in a regression but since *UAI* does not vary over time, this variable cannot be included alongside the country fixed effects. Dropping country fixed effects and including *UAI* separately does not change the results. All marginal effects and corresponding standard errors are estimated using the Stata lincom command.

[21] Lagged crises as well as other control variables are omitted from this equation, both for brevity and because they had no additional explanatory power in the regressions.

[22] See Thomas (2002) on partial adjustment mechanisms.

[23] A financial crisis that occurred two years ago no longer has a significant effect. One possible reason that one lag is significant and two lags is not could be that if a financial crisis occurs in the second half of a calendar year, the effects will be felt in the current and next year, while the uncertainty shock will have had time to wear of for the year after, see also Bloom (2009) on the dynamic effects of uncertainty shocks.

**Table 4**
Investment, financial crises and uncertainty avoidance.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Estimation method | FE | FE | FE | Diff-GMM | Sys-GMM | FE | IV |
| Lagged investment | 0.844*** | 0.844*** | 0.842*** | 0.958*** | 0.913*** | | 0.842*** |
| | (0.0161) | (0.0161) | (0.0166) | (0.0613) | (0.0372) | | (0.0163) |
| Lagged growth | 0.289* | 0.274* | 0.253* | 0.0526 | 0.132 | 0.195 | 0.256* |
| | (0.166) | (0.156) | (0.152) | (0.200) | (0.207) | (0.142) | (0.153) |
| Financial crisis | −0.0533*** | −0.0576*** | 0.0376 | 0.104** | 0.110** | 0.0474 | 0.0208 |
| | (0.0163) | (0.0152) | (0.0490) | (0.0472) | (0.0489) | (0.0523) | (0.0810) |
| Lagged financial crisis | | −0.0658*** | 0.0176 | 0.0562 | 0.0818 | 0.0228 | 0.103 |
| | | (0.0110) | (0.0466) | (0.0641) | (0.0593) | (0.0528) | (0.0702) |
| Financial crisis × UAI | | | −0.134** | −0.229*** | −0.233*** | −0.151** | −0.112 |
| | | | (0.0644) | (0.0627) | (0.0651) | (0.0684) | (0.116) |
| Lagged financial crisis × UAI | | | −0.112* | −0.173** | −0.211*** | −0.110 | −0.241** |
| | | | (0.0606) | (0.0816) | (0.0786) | (0.0676) | (0.0994) |
| *Marginal effect of a crisis significantly negative for countries with a UAI exceeding* | | | | | | | |
| Contemporaneous | | | 0.56 | 0.61 | 0.62 | 0.57 | 0.57 |
| Lagged | | | 0.49 | 0.57 | 0.57 | 0.54 | 0.57 |
| Observations | 2416 | 2416 | 2416 | 2342 | 2416 | 2416 | 2416 |
| R-squared | 0.749 | 0.746 | 0.753 | | | 0.061 | 0.753 |
| Number of countries | 74 | 74 | 74 | 74 | 74 | 74 | 74 |
| Sargan test (p-value) | | | | 0.0000 | 0.0000 | | |
| 1st order autocorrelation (p-value) | | | | 0.0000 | 0.0000 | | |
| 2nd order autocorrelation (p-value) | | | | 0.6726 | 0.6862 | | |

Notes: Dependent variable is investment in columns (1)-(5) and (7); it is the change in investment in column (6); see Table 1 for variable definitions and sources. Robust standard errors are in parentheses. Standard errors are clustered by country, except for the GMM specifications in columns (4) and (5). All specifications include year dummies. FE: country fixed effects; Diff-GMM: Arrelano-Bond (1991) estimator; Sys-GMM: Blundell-Bond (1995)/Arrelano-Bover (1998) estimator; IV: using the share of Protestants and the share of Catholics to predict UAI and use this predicted value in the model of column (3). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

with the highest UAI is Greece with an index of 1.12. This means that in a crisis year, the investment to GDP ratio would drop by more than 11% compared with an average negative effect of 5%.[24]

The statistical significance of these results is shown in Fig. 2, which plots the marginal effect together with the 95-percent confidence interval. This figure shows that in the year a financial crisis occurs, investment falls significantly relative to GDP in countries with a UAI above 0.56, which means countries that are less tolerant of uncertainty than, roughly Switzerland, or 45 out of the 74 countries in the sample. The investment response to a crisis a year ago turns significantly negative for a similar group of countries, namely those with a UAI above 0.49 or 57 out of 74 countries. Though we could make a figure similar to Fig. 2 for each specification that includes these interaction terms, we save space by only reporting the value of UAI where the 95% upper bound of the marginal effect turns negative, so in column (3), these values are 0.56 and 0.49.

After a financial crisis, the majority of countries experiences a significant decline in investment relative to GDP, but a sizeable minority does not, including Anglo-Saxon countries such as the UK and US. This does not reflect an absence of financial crises in countries with low UAI scores. About 40% of the countries have a UAI lower than 0.56 and these countries experienced about 35% of the financial crises (see Appendix Fig. 1 for the full distribution).

The specification in column (3) includes a lagged value of the dependent variable as one of the explanatory variables, and OLS no longer is consistent in that case. Moreover, there could be endogeneity concerns not adequately addressed by the inclusion of country fixed effects. Column (4) shows results using the Generalized Method of Moments (GMM) estimator proposed by Arrelano and Bond (1991) and column (5) shows results using the GMM-estimator suggested by Arrelano and Bover (1998) and Blundell and Bond (1995). In column (4), labeled 'Diff-GMM', the estimating equation is first-differenced and higher lags of dependent and explanatory variables are used as instruments. In column (5), labeled 'Sys-GMM', a system is estimated where lagged levels of variables are used as instruments for an equation in first differences (the Diff-GMM case) but also vice versa. [25] The estimation results are very similar to the FE results from column (3) except that the interaction effects are larger and more significant, but the group of countries where a financial crisis leads to a drop in investment is somewhat smaller.[26] The test for overidentifying restrictions shows a serious problem with these specifications though.[27] Under the null hypothesis of this test, the instruments are valid and this null hypothesis is overwhelmingly rejected. In other words, lagged differences of the crises dummy are not very good predictors of actual crises: not very surprising since financial crises are comparatively rare occurrences.[28] In other words, the GMM estimators do not lead to satisfactory models.[29]

To deal with the problem of a lagged dependent variable, a more radical solution is to use the change in the investment/GDP ratio as the dependent variable, rather than the level. Column (6) shows the results from estimating this model. The contemporaneous interaction term is still significantly negative, while the lagged interaction term is not. More importantly, the marginal effect is significantly negative for a very similar set of countries as in column (3). So these results show that the lagged dependent variable does not cause substantial estimation problems and that even country-specific *trends* in the

[24] Calculated as 0.0376–1.12*0.134.

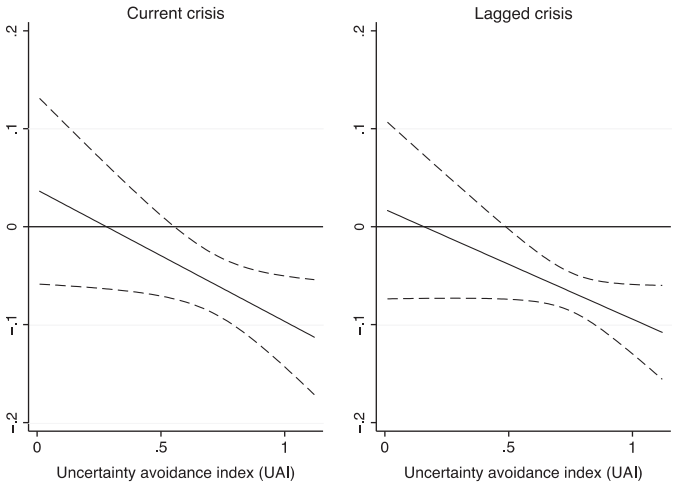
[25] We also considered the Anderson-Hsiao estimator, which does not rely on the number of cross-sections going to infinity for consistency. This leads to very similar results.

[26] Despite the significantly positive 'Crises' coefficient, the marginal effect of crises on investment is not significantly positive for any of the countries in the sample.

[27] The standard errors in columns (4) and (5) are robust to heteroscedasticity, but in that case the distribution of the test for overidentifying restrictions is not known. The p-value shown in Table 4 is based on estimation with homoscedastic errors. The errors are very similar in both cases and homoscedastic errors are available on request.

[28] The correlation between the crises dummy and a lagged difference of this dummy is 0.02.

[29] In the specifications of Table 4, all variables are treated as pre-determined. If all are treated as endogenous, the crisis variables are no longer significant. This could well be a weak instrument problem.




Note: Marginal effect based on estimation results in column (3) of Table 4 and calculated based on equation (2), using Stata's lincom command.

**Fig. 2.** Marginal effect of a financial crisis in the current year and one year ago ('lagged') and 95% confidence interval.

investment-output ratio do not distort the main finding that countries that are less tolerant of uncertainty show bigger drops in investment following a financial crisis. The explanatory power of this specification is much lower than the regressions in levels, though at 0.061 not negligible either.

So far, we have treated the tolerance for uncertainty as an exogenous variable that moderates the effect of a crisis on investment. However, it is conceivable that crisis-prone countries become less tolerant of uncertainty, which makes the crisis variable the moderating variable. To exclude this possibility, we instrument for uncertainty avoidance, using the same approach as Huang (2008). Following Huang (2008), we use the proportion of the population that is Catholic and the proportion that is Protestant in 1980.[30] Both variables turn out to be very relevant, with more catholic societies showing higher rates of uncertainty avoidance and more protestant societies showing lower rates of uncertainty avoidance. Together, these two variables explain about a quarter of cross-country variation in UAI. In column (7), we use the values of UAI predicted by the two religious composition variables to estimate the same model as in column (3). The results are very similar. As expected, the coefficient standard errors on the interaction terms are considerably higher than without instrumenting UAI, but the marginal effect of a financial crisis on investment still is significantly negative for nearly the same group of countries.

## 5. Types of crises

We next address whether the effect of a financial crisis differs depending on the type of crisis: banking, currency or debt. This need not be the case as each of these crises would likely lead to a period of heightened uncertainty. Table 5 provides evidence for this by separately including each of the three crisis dummies and lagged crisis dummies in column (1) and adding the interactions with UAI in column (2). Column (1) shows that all three crises have a significant negative effect on investment, either current, lagged or both. All three have a comparable effect on investment when adding together the current and lagged coefficient estimates and indeed, the effect of each type of crisis is statistically indistinguishable from the generic crisis effect from Table 4. The coefficients are less precisely estimated than the combined crises dummy, which also suggests that each crisis has a comparable effect: if each crisis had a very different effect on investment, one would expect a less precise estimate after combining the different crisis variables into a single crisis indicator.

Column (2) adds the interaction between the crisis dummies and the uncertainty avoidance index. These interaction terms are mostly insignificant, except for banking crises, but the main question is whether the marginal effect of a crisis on investment turns significantly negative for the countries that most intolerant of uncertainty. As the bottom panel shows, this is indeed the case. The group of countries for which investment is significantly lower after a crisis is smaller in many cases, which is not surprising given the higher coefficient standard errors compared to Table 4. Indeed, a debt crisis only has a significant negative effect in the year in which it occurs, as the effect of a lagged debt crisis never turns significantly negative.[31]

## 6. Types of investment

So far, we have analyzed how the effect of financial crises on total investment varies across countries, but there are good reasons to believe that this cross-country variation differs depending on the type of investment. Specifically, we consider three distinctions:

1. By type of investor: public or private
2. By type of asset: structures or machinery
3. By type of industry: low or high volatility

The argument for a differential effect of crises on investment is based on the theory of firm behavior. This theory argues that firms will sooner delay investments if the future payoff is highly uncertain (e.g. Bloom et al. 2007). Such arguments would *a priori* seem less plausible for public investment, where the overall fiscal policy stance and debt sustainability will matter more (see e.g. Mehrotra and Välilä, 2006). Table 6, columns (2) and (3) confirm this hypothesis. Column (2) shows that public investment significantly declines after a crisis for practically all countries: only Singapore has a UAI that is smaller than 0.11, the threshold shown. It is no surprise that public investment declines since, in particular, debt crises would be expected to have an overall negative impact of government finances and hence investment. In contrast, the results for private investment in column (3) are very much in line with those for overall investment.

The productive life span of capital assets vary considerably, with structures often expected to have services lives of around 40 years while the service life of machinery and equipment is typically closer to 15 years (see e.g. Fraumeni, 1997). This implies that uncertainty will likely have a larger effect on the expected payoff of investments in structures than in machinery and equipment. Columns (4) and (5) of Table 6 confirm this expected pattern. As detailed in the data appendix, coming up with reliable estimates for investment by asset for this range of countries is challenging and the measures for structures investment and machinery and equipment investment are both proxies, based on the total supply of structures, and machinery and equipment. Since these estimations are done independently, the number of observations differs. The potential for measurement error is also greater since these estimates cannot easily be linked to each other or to total investment in the National Accounts. Still, the results confirm the hypothesis: for investment in structures we find that only the more uncertainty-averse countries show significant declines while we find no significant effect for investment in machinery and equipment.

[30] Huang (2008) also considered the proportion of the population that is Muslim, but this variable turns out not to be a significant explanatory variable for UAI. Dropping countries without a sizable share of Christians (Protestant plus Catholic share less than 20%) does not affect the results.

[31] In addition, the marginal effect of a currency crisis turns insignificant again for very high levels of uncertainty avoidance, i.e. for the two countries with a UAI exceeding 1.01.

**Table 5**
Investment, different types of financial crisis and uncertainty avoidance.

| | (1) | (2) |
|---|---|---|
| Lagged investment | 0.842*** | 0.842*** |
| | (0.0163) | (0.0167) |
| Lagged growth | 0.249 | 0.241 |
| | (0.155) | (0.152) |
| Bank crisis | −0.0329 | 0.114** |
| | (0.0216) | (0.0573) |
| Lagged bank crisis | −0.0797*** | 0.0230 |
| | (0.0180) | (0.0578) |
| Currency crisis | −0.0532*** | −0.0480 |
| | (0.0190) | (0.0560) |
| Lagged currency crisis | −0.0326** | 0.00645 |
| | (0.0150) | (0.0634) |
| Debt crisis | −0.0539** | 0.120** |
| | (0.0248) | (0.0601) |
| Lagged debt crisis | −0.0480 | 0.0142 |
| | (0.0290) | (0.0870) |
| Bank crisis × UAI | | −0.213** |
| | | (0.0845) |
| Lagged bank crisis × UAI | | −0.148* |
| | | (0.0848) |
| Currency crisis × UAI | | −0.00789 |
| | | (0.0729) |
| Lagged currency crisis × UAI | | −0.0574 |
| | | (0.0785) |
| Debt crisis × UAI | | −0.251*** |
| | | (0.0843) |
| Lagged debt crisis × UAI | | −0.0889 |
| | | (0.115) |
| *Marginal effect of a crisis significantly negative for countries with a UAI exceeding* | | |
| Bank | | 0.75 |
| Lagged bank | | 0.47 |
| Currency | | 0.47 |
| Lagged currency | | 0.67 |
| Debt | | 0.65 |
| Lagged debt | | – |
| Observations | 2416 | 2416 |
| R-squared | 0.753 | 0.755 |
| Number of countries | 74 | 74 |

Notes: Dependent variable is investment; see Table 1 for variable definitions and sources. Robust standard errors are in parentheses. Standard errors are clustered by country. Both specifications include year and country dummies. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Industries may differ in their sensitivity to uncertainty from a financial crisis depending on the overall level of volatility in each industry. Indeed, just as some industries may exhibit greater growth opportunities than others (Bekaert et al., 2007), volatility of demand and cost shocks or other factors may lead to variation in the volatility of industries. Appendix Table 2 confirms this, showing the standard deviation of daily stock market returns for a range of industries. This table shows how, for example, the leather industry is more than twice as volatile as the food industry. We hypothesize that a financial crisis will have a greater effect in uncertainty-averse countries in industries with low volatility, such as the food industry. The argument would be that the more risk-averse investors will tend to invest in low-volatility industries and are likely to respond more strongly to a financial crisis.[32] Furthermore, a crisis increases total uncertainty by proportionally more in low-volatility industries, so this might also lead to a larger effect of a crisis.

Table 7 shows the regression results for industry investment. Column (1) of Panel A shows that a financial crisis has a negative (unconditional) effect on investment and the coefficient is quite close to that in Table 4, column (1). A lagged crisis variable turned out not to be significant as did lagged industry growth, so these are omitted. Column (2) adds the interaction of the crisis and country uncertainty avoidance while column (3) also adds the interactions with stock market volatility (see equation (4)). Panel B shows the marginal effects, first corresponding to the specification from Column (2), based on equation (2), and below that for Column (3), based on equation (5).

To interpret the results from the model with both uncertainty avoidance and stock market volatility, we evaluate the marginal effects at the 5th, 25th, 50th, 75th and 95th percentile for both variables. The first part of Panel B confirms the cross-country findings by showing that only the most uncertainty-averse countries show significant declines in investment after a financial crisis. The threshold at which investment turns significantly negative is at a higher UAI level (0.73), but the result is qualitatively similar. The bottom part of Panel B adds the industry volatility dimension and shows that any significant negative effect is still dependent on the degree of uncertainty aversion in the country in question but also on the volatility of the investing industry. Consistent with the hypothesis, the significant negative effects are concentrated in the less volatile industries, with highly volatile industries showing no significant effect. These results are particularly powerful since they show a differential effect *within* countries depending on the degree of industry volatility.[33]

## 7. Alternative economic variables

Table 8 analyzes a wide range of variables that have been suggested as explanatory variables for investment, notably in Joyce and Nabar (2009). The first column replicates the main estimation result, column (3) from Table 4. Every subsequent column adds a different control variable, described below the column number. The key test is whether any of the control variables would remove the moderating effect of uncertainty avoidance on crises. So each control variable is interacted with crises and lagged crises and, as described in equation (3), we evaluate the marginal effect of a crisis on investment conditional on both uncertainty avoidance and the control variable. As in earlier tables, we report the threshold value for uncertainty avoidance, above which investment declines significantly following a financial crisis. We determine this threshold at the mean of the control variable and the 25th and 75th percentile.[34]

The list of control variables includes the (nominal) interest rate, inflation rate, degree of trade openness, debt service to GDP ratio, FDI to GDP ratio, changes in the terms of trade, financial openness and financial development. There are instances where the control variable or the interaction of the control variable is significant, but uncertainty aversion remains important in moderating the effect of a financial crisis on investment. Indeed, the threshold value only varies modestly across the alternative models and for different values of the control variable.

## 8. Alternative sample and uncertainty measures

Table 9 considers the robustness of our results to different subsets of countries (columns (2) and (3)); an alternative source for the dependent variable (column (4)); and alternative measures of uncertainty avoidance (columns (5)–(11)). Column (2) limits the sample to low-income countries, i.e. non-OECD countries, and column (3) removes Latin American countries, the more crisis-prone countries in the dataset. Column (4) uses the investment/GDP ratio as given in the World Development Indicators (WDI). In our main results, we calculate the investment/GDP ratio using constant prices data to focus on the adjustment of the quantity of investment rather than the value. The WDI measure, used by Joyce and Nabar

[32] See e.g. Barsky et al. (1997) and Dohmen et al. (2011) on risk preferences and investment behavior. A corollary of this argument would be that uncertainty-averse countries would have a larger share of investors preferring low-volatility industries, an implication we are not analyzing here.

[33] Furthermore, these findings are robust to dropping individual industries.

[34] Evaluating the control variables at the 5th and 95th percentile does not materially alter the findings.

**Table 6**
Investment by type of investor and type of asset, financial crises and uncertainty avoidance.

| Dependent variable | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Total investment | Public investment | Private investment | Structure investment | Machinery & eq. investment |
| Lagged investment | 0.842*** | 0.764*** | 0.860*** | 0.879*** | 0.694*** |
| | (0.0166) | (0.0552) | (0.0240) | (0.0119) | (0.0917) |
| Lagged growth | 0.253* | 0.302 | 0.0811 | 0.279*** | 0.174 |
| | (0.152) | (0.204) | (0.316) | (0.0801) | (0.289) |
| Crises | 0.0376 | −0.180* | 0.0553 | 0.0368 | −0.00444 |
| | (0.0490) | (0.102) | (0.0613) | (0.0302) | (0.108) |
| Lagged crises | 0.0176 | 0.0777 | 0.0266 | −0.00430 | 0.110 |
| | (0.0466) | (0.0977) | (0.0628) | (0.0306) | (0.0951) |
| Crises × UAI | −0.134** | 0.0959 | −0.176* | −0.100** | −0.0281 |
| | (0.0644) | (0.162) | (0.0925) | (0.0470) | (0.138) |
| Lagged crises × UAI | −0.112* | −0.164 | −0.140 | −0.0179 | −0.160 |
| | (0.0606) | (0.149) | (0.0860) | (0.0420) | (0.145) |
| *Marginal effect of a crisis significantly negative for countries with a UAI exceeding* | | | | | |
| Contemporaneous | 0.56 | 0.11 | 0.54 | 0.61 | . |
| Lagged | 0.49 | . | 0.53 | . | . |
| Observations | 2416 | 933 | 933 | 2348 | 1822 |
| R-squared | 0.753 | 0.723 | 0.782 | 0.839 | 0.578 |
| Number of countries | 74 | 39 | 39 | 72 | 69 |

Notes: Dependent variable is listed below the column numbers; see Table 1 for variable definitions and sources. Robust standard errors are in parentheses. Standard errors are clustered by country. All specifications include year and country dummies. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

(2009), is measured at current prices, so any effect includes both a price and quantity effect. The results are very similar to our baseline results, shown in column (1).

Column (5) excludes all countries for which Hofstede had no direct survey evidence; i.e. countries annotated with asterisks in Table 3. This has little effect on the results. In columns (6) through (8), we use the UAI data from the Hoppe and EMMS survey and the risk-loving measure from the WVS. Columns (9) through (11) are based on predicted values of uncertainty avoidance and risk preference. As in the final column of Table 4, we use the Catholic and Protestant shares to estimate the relationship between Catholic and Protestant shares and UAI/risk-loving and predict their values for all 74 countries. This way, we hope to focus on the effect of using a different survey distinct from the effect of more limited country coverage.

The three alternative measures in columns (6)–(8) show lower thresholds, i.e. a larger number of countries that show significant declines in investment after a crisis. The WVS risk-loving measure even implies declines for all countries, though significantly larger

**Table 7**
Investment by industry, financial crises, uncertainty avoidance and industry volatility.

| Panel A, Regression estimates | | | | | |
|---|---|---|---|---|---|
| Model | | (1) | (2) | | (3) |
| Lagged industry investment | | 0.581*** | 0.581*** | | 0.581*** |
| | | (0.0353) | (0.0353) | | (0.0353) |
| Crises | | −0.0505** | 0.0329 | | 0.811* |
| | | (0.0235) | (0.101) | | (0.417) |
| Crises × UAI | | | −0.111 | | −1.137** |
| | | | (0.125) | | (0.518) |
| Crises × Volatility | | | | | −0.755* |
| | | | | | (0.418) |
| Crises × UAI × Volatility | | | | | 0.996* |
| | | | | | (0.517) |
| Observations | | 29777 | 29777 | | 29777 |
| R-squared | | 0.344 | 0.344 | | 0.344 |
| Country × industry pairs | | 1585 | 1585 | | 1585 |
| Panel B, Marginal effects | | | | | |
| UAI (percentile) | 0.29 (5th) | 0.48 (25th) | 0.68 (50th) | 0.86 (75th) | 1.01 (95th) |
| *Marginal effect of a financial crises conditional on country UAI, column (2)* | | | | | |
| | 0.001 | −0.02 | −0.043 | −0.062** | −0.079** |
| *Marginal effect of a financial crises conditional on industry volatility and country UAI, column (3)* | | | | | |
| Volatility (percentile) | | | | | |
| 0.0069 (5th) | 0.16 | 0.074 | −0.016 | −0.097** | −0.164*** |
| 0.0082 (25th) | 0.099 | 0.038 | −0.026 | −0.084*** | −0.132*** |
| 0.0101 (50th) | 0.011 | −0.014 | −0.041 | −0.064*** | −0.084** |
| 0.0111 (75th) | −0.036 | −0.042 | −0.049* | −0.054** | −0.059 |
| 0.0154 (95th) | −0.237 | −0.161 | −0.082 | −0.011 | 0.049 |

Notes:
Dependent variable is industry investment; see Table 1 for variable definitions and sources. Robust standard errors are in parentheses. Standard errors are clustered by country × industry pair. All specifications include country × industry dummies and year dummies. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

**Table 8**
Investment, financial crises and uncertainty avoidance: robustness to alternative explanatory variables.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Control variable | - | Interest rate | Inflation | Trade Openness | Debt service | FDI | Terms of trade | Fin. Openness | Fin. Develop. |
| Lagged investment | 0.842*** | 0.810*** | 0.844*** | 0.836*** | 0.833*** | 0.827*** | 0.835*** | 0.827*** | 0.842*** |
| | (0.0166) | (0.0173) | (0.0156) | (0.0177) | (0.0233) | (0.0232) | (0.0178) | (0.0220) | (0.0231) |
| Lagged growth | 0.253* | 0.216 | 0.423*** | 0.252* | 0.468*** | 0.374** | 0.618*** | 0.238 | 0.402* |
| | (0.152) | (0.196) | (0.141) | (0.143) | (0.155) | (0.143) | (0.0986) | (0.154) | (0.223) |
| Crises | 0.0376 | 0.0314 | 0.0201 | 0.0954 | 0.0533 | 0.0166 | 0.00107 | 0.0870 | 0.0370 |
| | (0.0490) | (0.0491) | (0.0401) | (0.0811) | (0.0641) | (0.0523) | (0.0468) | (0.0546) | (0.0484) |
| Lagged crises | 0.0176 | 0.0351 | 4.81e-05 | 0.0662 | 0.0183 | -0.0297 | -0.0241 | 0.0486 | 0.0132 |
| | (0.0466) | (0.0509) | (0.0513) | (0.0563) | (0.0571) | (0.0591) | (0.0360) | (0.0476) | (0.0609) |
| Crises × UAI | -0.134** | -0.107 | -0.114* | -0.160** | -0.174** | -0.122** | -0.0955 | -0.168** | -0.115* |
| | (0.0644) | (0.0690) | (0.0591) | (0.0773) | (0.0722) | (0.0549) | (0.0689) | (0.0672) | (0.0650) |
| Lagged crises × UAI | -0.112* | -0.153** | -0.0860 | -0.131** | -0.108 | -0.0736 | -0.0467 | -0.146** | -0.0976 |
| | (0.0606) | (0.0698) | (0.0658) | (0.0602) | (0.0720) | (0.0726) | (0.0485) | (0.0604) | (0.0737) |
| Control | | 0.000461 | -0.000172 | 0.103** | -0.0510 | 0.162** | 0.0144 | 0.000680 | -0.866 |
| | | (0.00113) | (0.00131) | (0.0422) | (0.149) | (0.0655) | (0.0573) | (0.0259) | (2.606) |
| Control × Crises | | -0.0336 | -0.00230 | -0.0738 | 0.0398 | 0.360 | 0.111 | -2.269* | -4.436 |
| | | (0.0229) | (0.00234) | (0.0646) | (0.255) | (1.621) | (0.141) | (1.219) | (3.601) |
| Control × Lagged crises | | 0.00572 | -0.000388 | -0.0670 | 0.0214 | 1.352* | 0.0156 | -0.686 | -3.372 |
| | | (0.0122) | (0.00214) | (0.0409) | (0.122) | (0.771) | (0.102) | (0.858) | (2.985) |
| Marginal effect of a crisis significantly negative for countries with a UAI exceeding | | | | | | | | | |
| *Evaluated at the mean for Control* | | | | | | | | | |
| Contemporaneous | 0.56 | 0.59 | 0.45 | 0.52 | 0.54 | 0.57 | 0.42 | 0.54 | 0.43 |
| Lagged | 0.48 | 0.51 | 0.48 | 0.44 | 0.55 | 0.59 | 0.34 | 0.51 | 0.44 |
| *Evaluated at the 25th percentile for Control* | | | | | | | | | |
| Contemporaneous | | 0.66 | 0.46 | 0.63 | 0.59 | 0.57 | 0.42 | 0.63 | 0.56 |
| Lagged | | 0.51 | 0.48 | 0.56 | 0.56 | 0.42 | 0.34 | 0.54 | 0.53 |
| *Evaluated at the 75th percentile for Control* | | | | | | | | | |
| Contemporaneous | | 0.61 | 0.46 | 0.49 | 0.52 | 0.55 | 0.42 | 0.56 | 0.39 |
| Lagged | | 0.51 | 0.48 | 0.41 | 0.55 | 0.57 | 0.33 | 0.51 | 0.40 |
| Observations | 2416 | 1625 | 2301 | 2416 | 1234 | 2036 | 2042 | 2253 | 2021 |
| R-squared | 0.753 | 0.734 | 0.772 | 0.758 | 0.770 | 0.747 | 0.776 | 0.734 | 0.744 |
| Number of country | 74 | 70 | 74 | 74 | 44 | 71 | 72 | 73 | 72 |

Notes: Dependent variable is investment; see Table 1 for variable definitions and sources. The lines 'Control' , 'Control × Crises' and 'Control × Lagged crises' show the coefficient estimate of the control variable listed at the top of the relevant column (interest rate, inflation, etc.). Robust standard errors are in parentheses. Standard errors are clustered by country. All specifications include year and country dummies. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

declines in countries with a greater aversion to risk-taking (for lagged crises). Using the predicted values of the measures in columns (9)–(11) shows the Hoppe and EMMS thresholds at very similar levels as for the original Hofstede measures and similar results as in column (8) for the WVS measure. This suggests that for the same set of countries and the same concept (uncertainty avoidance) the results are very similar. The WVS measure is conceptually somewhat different, focusing on risk-taking rather than uncertainty avoidance, but even there the results are broadly in line.

## 9. Institutional variables

We would argue that our results so far have established that firms in more uncertainty-averse countries respond differently to financial crises than those in less uncertainty-averse countries. However, this still raises the question what is behind this effect. On the one hand, uncertainty aversion may directly affect the investment decisions of firm owners. Alternatively, uncertainty aversion may give rise to institutions that reduce uncertainty but increase adjustment costs of firms. One example of such an institution is employment-protection legislation.[35] More broadly, uncertainty aversion could be correlated with measures of governance quality, which would mean our findings could reflect poor government response to a crisis.

We would argue the systematic differences across industries in Table 7 suggests our main findings are related to how firm owners respond to uncertainty, rather than how they respond to the institutional setting. If firms were responding only to the institutional setting, it is not clear why this response would vary between more and less volatile industries. Table 10 provides more direct evidence against institutional factors driving the investment response. Columns (2)–(4) examine the effect of three 'institutional rigidity' indicators, while columns (5)–(10) examine indicators of governmental quality.

The 'institutional rigidity' indicators include the aforementioned employment protection indicator from Botero et al. (2004), which is based on the strictness of regulations regarding hiring, firing and working hours; an indicator for legal formalism from Djankov et al. (2003), which reflects to what extent legal decisions can rely on principles of equity rather than law; and a dummy variable from La Porta et al. (2004) that is one if previous legal decisions can be used as a source of law. If case law can be used, the legal system tends to be more adaptable. Higher values for the formalism and employment protection measures indicate less flexible systems.

The indicators of government quality are those of Kaufman et al. (2010) and cover six dimensions: 1) voice and accountability; 2) political stability; 3) government effectiveness; 4) regulatory quality; 5) rule of law; and 6) control of corruption. Along all these dimensions, higher values correspond to higher quality, stability, etc. Results for these dimensions are available annually for the 1996–2009 period but since this covers only a small part of our sample period, we decided to average over the 1996–2009 period and use this as an indicator for the entire 1970–2005 period.

[35] See Bloom (2009) on how labor adjustment costs can affect the response of capital investment to demand conditions.

**Table 9**
Investment, financial crises and uncertainty avoidance: robustness to alternative samples and data source for investment and uncertainty avoidance.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Specification | Baseline | Low-income | No Latin Am. | WDI I/Y | High-quality UAI | Hoppe UAI | EMMS UAI | WVS Risk-loving | Pred. Hoppe | Pred. EMMS | Pred. WVS |
| Lagged investment | 0.842*** | 0.849*** | 0.846*** | 0.725*** | 0.814*** | 0.833*** | 0.859*** | 0.883*** | 0.845*** | 0.845*** | 0.845*** |
| | (0.0166) | (0.0188) | (0.0201) | (0.0323) | (0.0160) | (0.0218) | (0.0160) | (0.0183) | (0.0161) | (0.0162) | (0.0163) |
| Lagged growth | 0.253* | 0.257 | 0.171 | 0.439** | 0.898*** | 0.590*** | 0.845*** | 0.618*** | 0.274* | 0.271* | 0.272* |
| | (0.152) | (0.198) | (0.140) | (0.210) | (0.126) | (0.159) | (0.0884) | (0.0993) | (0.155) | (0.155) | (0.155) |
| Financial crisis | 0.0376 | 0.0673 | 0.00219 | 0.0331 | -0.0117 | -0.0689 | -0.0741* | -0.0817*** | -0.0598 | 0.00190 | 0.0159 |
| | (0.0490) | (0.0562) | (0.0591) | (0.0627) | (0.0362) | (0.0439) | (0.0388) | (0.0141) | (0.0821) | (0.0616) | (0.0524) |
| Lagged financial crisis | 0.0176 | 0.0167 | -0.0342 | 0.00593 | 0.0167 | -0.0146 | 0.000867 | -0.0332*** | 0.115 | 0.0758 | 0.0224 |
| | (0.0466) | (0.0517) | (0.0437) | (0.0652) | (0.0526) | (0.0373) | (0.0340) | (0.0108) | (0.0884) | (0.0551) | (0.0471) |
| Financial crisis × UAI | -0.134** | -0.174** | -0.0627 | -0.132 | -0.0987* | 0.00512 | 0.0333 | -1.208 | 0.00633 | -0.0977 | -15.97 |
| | (0.0644) | (0.0740) | (0.0754) | (0.0865) | (0.0526) | (0.168) | (0.0382) | (2.106) | (0.216) | (0.0976) | (10.78) |
| Lagged financial crisis × UAI | -0.112* | -0.105 | -0.0221 | -0.0841 | -0.0971 | -0.164 | -0.0936* | -3.887** | -0.480** | -0.231*** | -19.14** |
| | (0.0606) | (0.0687) | (0.0580) | (0.0954) | (0.0652) | (0.105) | (0.0458) | (1.446) | (0.228) | (0.0845) | (9.323) |
| *Marginal effect of a crisis significantly negative for countries with a UAI exceeding* | | | | | | | | | | | |
| Contemporaneous | 0.56 | 0.61 | 0.67 | 0.59 | 0.31 | 0.07 | 0.06 | 0.01 | 0.26 | 0.46 | 0.01 |
| Lagged | 0.49 | 0.52 | 0.41 | 0.58 | 0.55 | 0.18 | 0.47 | 0.01 | 0.32 0.48 | 0.01 | |
| Observations | 2416 | 1464 | 1872 | 2284 | 1598 | 612 | 510 | 1252 | 2416 | 2416 | 2416 |
| R-squared | 0.753 | 0.766 | 0.751 | 0.616 | 0.809 | 0.803 | 0.860 | 0.842 | 0.746 | 0.747 | 0.746 |
| Number of countries | 74 | 46 | 58 | 74 | 47 | 18 | 15 | 38 | 74 | 74 | 74 |

Notes: Dependent variable is investment; see Table 1 for variable definitions and sources. Baseline specification in column (1) corresponds with column (3) from Table 4. Column (2) excludes OECD countries; column (3) excludes Latin American countries; column (4) uses the log of the investment to GDP ratio from the World Development Indicators (WDI); column (5) excludes countries where the Hofstede UAI score in Table 3 is marked with one or two asterisks; column (6) uses the Hoppe UAI scores from Table 3; column (8) uses the WVS scores from Table 3; column (7) uses the EMMS UAI scores from Table 3; column (9) uses the predicted value of the Hoppe UAI score where the prediction is based on the relationship between the shares of Protestants and Catholics for the 18 countries of the Hoppe UAI sample; and column (11) performs the same procedure for the WVS indicator; column (10) performs the same procedure for the 15 countries of the EMMS UAI sample. Robust standard errors are in parentheses. Standard errors are clustered by country. All specifications include year and country dummies. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

**Table 10**
Investment, financial crises and uncertainty avoidance: robustness to rigid institutions and government quality indicators.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Control variable | - | Emp. Protect. | Formalism | Case law | Voice | Stability | Effectiveness | Reg. Qual. | Rule of Law | Corruption |
| Lagged investment | 0.842*** | 0.861*** | 0.847*** | 0.856*** | 0.842*** | 0.842*** | 0.843*** | 0.843*** | 0.842*** | 0.843*** |
| | (0.0166) | (0.0167) | (0.0168) | (0.0198) | (0.0166) | (0.0166) | (0.0166) | (0.0166) | (0.0166) | (0.0166) |
| Lagged growth | 0.253* | 0.302 | 0.227 | 0.176 | 0.251* | 0.254* | 0.253* | 0.253* | 0.252 | 0.252 |
| | (0.152) | (0.244) | (0.163) | (0.152) | (0.150) | (0.152) | (0.152) | (0.152) | (0.151) | (0.151) |
| Crises | 0.0376 | -0.0151 | 0.0395 | 0.00462 | -0.00455 | 0.0346 | 0.0298 | 0.0241 | 0.0270 | 0.0233 |
| | (0.0490) | (0.0462) | (0.0688) | (0.0430) | (0.0424) | (0.0514) | (0.0464) | (0.0467) | (0.0593) | (0.0459) |
| Lagged crises | 0.0176 | 0.0504 | 0.0677 | -0.0127 | 0.00655 | 0.0189 | 0.0188 | 0.0198 | 0.0269 | 0.0213 |
| | (0.0466) | (0.0533) | (0.0533) | (0.0416) | (0.0521) | (0.0480) | (0.0464) | (0.0459) | (0.0504) | (0.0482) |
| Crises × UAI | -0.134** | -0.167** | -0.111 | -0.0908 | -0.0730 | -0.132** | -0.121* | -0.109* | -0.121 | -0.116* |
| | (0.0644) | (0.0662) | (0.0702) | (0.0627) | (0.0577) | (0.0641) | (0.0614) | (0.0616) | (0.0727) | (0.0618) |
| Lagged crises × UAI | -0.112* | -0.126** | -0.0943 | -0.0979* | -0.0970 | -0.113* | -0.114* | -0.116* | -0.123* | -0.117* |
| | (0.0606) | (0.0514) | (0.0572) | (0.0527) | (0.0685) | (0.0616) | (0.0613) | (0.0614) | (0.0657) | (0.0636) |
| Control × Crises | | 0.136 | -0.00726 | -0.0332 | -0.0479** | -0.00704 | -0.0272* | -0.0353** | -0.0137 | -0.0212 |
| | | (0.109) | (0.0189) | (0.0331) | (0.0210) | (0.0211) | (0.0146) | (0.0159) | (0.0219) | (0.0147) |
| Control × Lagged crises | | -0.0486 | -0.0150 | 0.0223 | -0.00692 | 0.00409 | 0.00641 | 0.00831 | 0.0118 | 0.00648 |
| | | (0.0658) | (0.0125) | (0.0233) | (0.0133) | (0.0125) | (0.0161) | (0.0169) | (0.0135) | (0.0132) |
| Marginal effect of a crisis significantly negative for countries with a UAI exceeding | | | | | | | | | | |
| *Evaluated at the mean for Control* | | | | | | | | | | |
| Contemporaneous | 0.56 | 0.55 | 0.51 | 0.34 | 0.39 | 0.59 | 0.47 | 0.46 | 0.60 | 0.47 |
| Lagged | 0.49 | 0.48 | 0.49 | 0.40 | 0.50 | 0.51 | 0.52 | 0.52 | 0.53 | 0.53 |
| *Evaluated at the 25th percentile for Control* | | | | | | | | | | |
| Contemporaneous | | 0.42 | 0.56 | 0.80 | 0.81 | 0.57 | 0.63 | 0.63 | 0.55 | 0.61 |
| Lagged | | 0.55 | 0.57 | 0.39 | 0.48 | 0.49 | 0.49 | 0.48 | 0.47 | 0.49 |
| *Evaluated at the 75th percentile for Control* | | | | | | | | | | |
| Contemporaneous | | 0.78 | 0.54 | 0.31 | 0.20 | 0.71 | 0.37 | 0.35 | 0.69 | 0.42 |
| Lagged | | 0.47 | 0.47 | 0.47 | 0.54 | 0.57 | 0.67 | 0.65 | 0.63 | 0.63 |
| Observations | 2416 | 2014 | 2252 | 1748 | 2416 | 2416 | 2416 | 2416 | 2416 | 2416 |
| R-squared | 0.753 | 0.790 | 0.766 | 0.775 | 0.754 | 0.753 | 0.754 | 0.754 | 0.753 | 0.754 |
| Number of country | 74 | 61 | 68 | 52 | 74 | 74 | 74 | 74 | 74 | 74 |

Notes: Dependent variable is investment; see Table 1 for variable definitions and sources. The lines 'Control × Crises' and 'Control × Lagged crises' show the coefficient estimate of the control variable listed at the top of the relevant column. Robust standard errors are in parentheses. Standard errors are clustered by country. All specifications include year and country dummies. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The set-up of Table 10 is the same as Table 8, except that because the control variables are not time varying, only interactions with crises and lagged crises are included. Of main interest are the marginal effects, evaluated at the mean, 25th and 75th percentile of the control variable.[36] Our results remain robust throughout: investment only declines significantly after a financial crisis in the most uncertainty averse countries. In other words, our differential effect does not seem to be driven by more rigid institutions or less effective government, but may instead directly reflect the preferences of firm owners.

## 10. Conclusions

Financial crises tend to have severe effects on the real economy, leading to substantial drops in output and investment. What we set out to show in this paper is that the degree to which investment falls after a crisis differs significantly across countries depending on their tolerance for uncertainty. We have shown that after a crisis, investment falls no faster than GDP in countries with a high tolerance for uncertainty. Conversely, in countries with a low tolerance for uncertainty, investment falls significantly faster than GDP.

This result can be understood by considering that a financial crisis of any sort is a major source of uncertainty. A firm or household facing increased uncertainty would often prefer to wait for more stable times rather than commit money to an investment. Put differently, the real option value of waiting increases following an uncertainty shock like a financial crisis. Analysis of the macroeconomic effects of uncertainty shocks is relatively new, but the work of Bloom (2009) shows these effects can be considerable. Our analysis fits well into this framework.

Our main effect, investment declines significantly in the more uncertainty-averse countries, is similar for each type of financial crisis. We also find this effect only for private investment; that it is stronger for (long-lived) investment in structures; and only for manufacturing industries that are inherently less volatile. Furthermore, our findings are not driven by governments in more uncertainty-averse countries adopting less flexible institutions, suggesting that firm owners in more uncertainty-averse countries weigh the real option value of delaying investment differently from those in less uncertainty-averse countries.

This finding is relevant for policy. It may well be impossible to avoid all negative effects from a financial crisis, but a large drop in investment would be particularly harmful for long-run economic growth as it hampers capital accumulation. Avoiding such a drop in investment is particularly pressing in countries where the uncertainty aversion is high according to our findings. In these countries, confidence-building measures following a financial crisis, such as IMF agreements or rapid restructuring of sovereign debt, would be particularly pressing.

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[36] Again, similar results are obtained at the 5th and 95th percentile.

## Data Appendix

This appendix describes in some more detail the data sources, choices and assumptions made in constructing some of the variables listed in Table 1.

**Appendix Table 1**
Descriptive statistics.

| Variable | Number of observations | Average | Standard deviation |
|---|---|---|---|
| Investment | 2564 | −1.54 | 0.36 |
| Growth | 2490 | 0.03 | 0.06 |
| Public investment | 1004 | −4.02 | 0.95 |
| Private investment | 1004 | −1.62 | 0.24 |
| Structure investment | 2492 | −1.92 | 0.49 |
| Machinery & eq. investment | 1960 | −2.54 | 1.03 |
| Industry investment | 33456 | −2.09 | 1.28 |
| WDI I/Y | 2438 | −1.52 | 0.31 |
| Interest rate | 1724 | 0.22 | 1.26 |
| Inflation | 2464 | 0.29 | 1.97 |
| Trade Openness | 2564 | 0.70 | 0.54 |
| Debt service | 1317 | 6.24 | 4.86 |
| FDI | 2163 | 2.75 | 15.86 |
| Terms of trade | 2123 | −0.46 | 15.20 |
| Fin. Openness | 2402 | 2.38 | 10.99 |
| Fin. Develop. | 2171 | 0.51 | 0.39 |
| Emp. Protect. | 2196 | 0.46 | 0.19 |
| Formalism | 2448 | 3.67 | 1.00 |
| Case law | 1872 | 0.62 | 0.49 |
| Voice | 2664 | 0.21 | 0.95 |
| Stability | 2664 | 0.04 | 0.94 |
| Effectiveness | 2664 | 0.51 | 0.96 |
| Reg. Qual. | 2664 | 0.50 | 0.86 |
| Rule of Law | 2664 | 0.15 | 0.97 |
| Corruption | 2664 | 0.42 | 1.07 |

Note: For variable definitions see Table 1. For descriptive statistics for financial crisis variables see Table 2 and Appendix Fig. 1. For other country-level variables, see Table 3.

### Public and private investment

There are broadly two approaches to distinguishing public and private investment: the first defines investment by institutional sector and the second by industry; see e.g. Kamps (2006). This distinction is best understood when considering education. Education is a distinct industry (economic activity), but it can be both privately and publicly funded. As a result, part of education will be in the government sector and part in the private sector. As a practical matter though, collecting data on investment by industry results in a more comprehensive country coverage, so we opted for that approach.

Our main data source is the United Nations (UN) *National Accounts Official Country Data* publication, which provides data on gross fixed capital formation by the public administration industry and total economy investment. The public administration industry corresponds to ISIC division L and hence excludes health and education to focus on government investments, such as infrastructure. In addition to this source, we collected information from the EU KLEMS industry database (O'Mahony and Timmer, 2009) for Japan and the National Accounts of Argentina. Together, this provided us with data for 39 countries on the share of public investment. This share, based on data at current prices, was applied to our investment series at constant prices from the UN *National Accounts Estimates of Main Aggregates* publication (for both UN publications, see data.un.org). This assumes that the price trends for public and private investment are the same, as we lack the necessary data on investment prices.

### Structures and machinery & equipment investment

Although data on investment by asset type is available for a range of OECD countries, we wanted to achieve more comprehensive country

coverage. So instead, we construct measures of the total supply of the investment assets based on industry output and international trade data. This is most straightforward for structures, since this is practically non-traded and most of industry output is used for investment.

This can be illustrated using data for the United States in 2005 from the Annual Make-Use Tables published by the Bureau of Economic Analysis. Construction industry output was $1180 bln and total investment in structures totaled $1363 bln. There are three main 'wedges' between these two numbers: 1) the construction industry does not produce all construction 'products' of the economy (in the US in 2005, 10% was produced by other industries); 2) some construction 'products' are used as intermediate inputs (13%); and 3) investment in structures also consists of other 'products', such as architectural services (15%). What matters most, though, is not the size of these wedges, but whether construction industry output and structures investment follow similar trends over time. Data for the US suggests they do: the growth rates of these two series show a 0.96 correlation.

More challenging is machinery and equipment investment since these products are traded and their use is more widespread. Again using the US in 2005 as an illustration, we calculate the supply of machinery and equipment investment goods as the sum of industry output and imports and subtract exports. We include manufacturing industries that produce machinery and transport equipment. Of this total supply, 40% is used as investment, 42% as intermediate use and the remainder as consumption. But despite this much larger 'wedge', the trend in machinery & equipment supply and investment is still very similar with a correlation of 0.86 between the growth rates of these series.

To estimate total supply of structures, we take value added (at constant prices) of the construction industry from the UN *National Accounts Estimates of Main Aggregates* publication and combine it with estimates of the gross output/value added ratio from the UN *National Accounts Official Country Data* publication, the EU KLEMS database and IO tables from the GTAP 7 database. Dividing by GDP at constant prices gives the variable used in estimation.

To estimate total supply of machinery and equipment, we collect value added for overall manufacturing; gross output and value added for machinery & equipment industries; and exports and imports. The output data are from the UNIDO INDSTAT3 and INDSTAT4 (ISIC rev.2 and ISIC rev.3) databases and the trade data are from the Feenstra et al. (2005) World Trade Flows (WTF) database with an update for more recent years. The UNIDO data would frequently have a gap of one or more years, breaking the time series. We therefore supplemented UNIDO data with other sources, such as EU KLEMS but we also interpolated small gaps when the trade data suggested that no sharp movements occurred. Finally, to put the series on a comparable price basis as for structures investment, we calculated total supply as a share of manufacturing value added (at current prices) using UNIDO and WTF and applied it to manufacturing value added at constant prices from the UN *National Accounts Estimates of Main Aggregates* publication. Dividing by GDP at constant prices gives the variable used in estimation.

## Industry investment and volatility

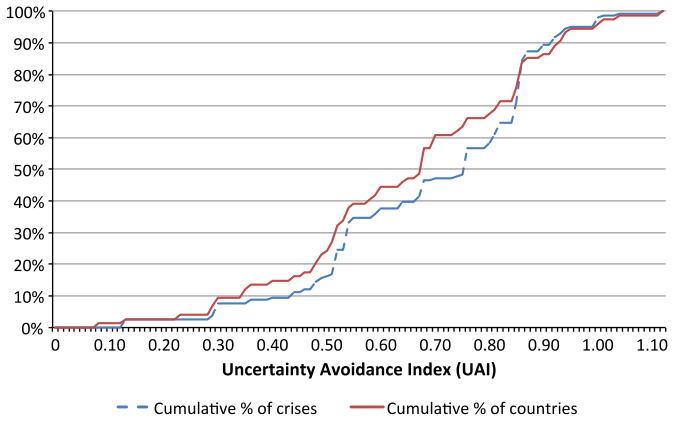
The UNIDO INDSTAT3 database contains information on both industry gross fixed capital formation and value added. The database covers manufacturing industries at the 3-digit level, which provides us with data for 28 industries, and covers the period 1970–2003. Moreover, the database contains data for 66 out of the 74 countries in this study. Although there are a considerable number of gaps and missing industries, more than 75% of the industry/country pairs have data for at least 10 years.

To measure industry volatility, we used a range of sectoral stock indexes from Datastream. These are available since 1973 and can be used to compute the standard deviation of daily stock returns. The Datastream stock market indexes were matched to the (ISIC rev. 2) industry list by name and in some cases the same index was matched to more than one industry, see Appendix Table 2. The matching is available on request.

**Appendix Table 2**
Industry volatility.

| Industry | ISIC rev.2 code | Volatility |
|---|---|---|
| Leather products | 323 | 0.01543 |
| Footwear, except rubber or plastic | 324 | 0.01543 |
| Other manufactured products | 390 | 0.01384 |
| Machinery, electric | 383 | 0.01357 |
| Wood products, except furniture | 331 | 0.01304 |
| Tobacco | 314 | 0.01168 |
| Iron and steel | 371 | 0.01105 |
| Non-ferrous metals | 372 | 0.01105 |
| Fabricated metal products | 381 | 0.01105 |
| Furniture, except metal | 332 | 0.01093 |
| Professional & scientific equipment | 385 | 0.01086 |
| Transport equipment | 384 | 0.01063 |
| Machinery, except electrical | 382 | 0.01061 |
| Textiles | 321 | 0.01012 |
| Wearing apparel, except footwear | 322 | 0.01012 |
| Printing and publishing | 342 | 0.00960 |
| Petroleum refineries | 353 | 0.00959 |
| Misc. petroleum and coal products | 354 | 0.00959 |
| Paper and products | 341 | 0.00899 |
| Other chemicals | 352 | 0.00867 |
| Industrial chemicals | 351 | 0.00818 |
| Rubber products | 355 | 0.00818 |
| Plastic products | 356 | 0.00818 |
| Pottery, china, earthenware | 361 | 0.00794 |
| Glass and products | 362 | 0.00794 |
| Other non-metallic mineral products | 369 | 0.00794 |
| Food products | 311 | 0.00685 |
| Beverages | 313 | 0.00685 |

Source: calculations based on Datastream, see Table 1.
Notes: standard deviation of daily stock returns for sectoral stock market indexes, calculated over the period 1973–2005.




**Appendix Figure 1, Distribution of countries and crises across UAI values.**

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